Examiners' Report

Principal Examiner Feedback

Summer 2022

Pearson Edexcel GCE

AS Mathematics (8MA0)

Paper 01 Core Mathematics

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Introduction

The AS level Pure Mathematics paper for the new specification seemed to be of an appropriate standard which was very accessible. In addition, the ramping of the paper was such that candidates found the first three questions the easiest and the final three questions the most challenging.

Candidates should continue to be reminded to read the questions carefully and any emboldened instructions, which particularly draw attention to the use of calculators and showing all stages of their working. It appeared as though some candidates are relying too heavily on their calculator with some resorting to the equation solver. Whilst these may be useful for checking answers, it is important that candidates show their method on any question which is one of the instructions on the front of the paper; candidates may not score all the available marks with a correct answer from little or no working on any question.

Comments on individual questions

Question 1

The vast majority scored M1 for either $2x^4$ or $5x$. The most common error was dealing with coefficient of $x^{\frac{1}{2}}$ with a substantial number of candidates who were unable to process the fractional power. Many candidates rewrote the term as $\frac{3}{2}x^{\frac{1}{2}}$ while others made mistakes with the coefficient and rewrote it as $6x^{\frac{1}{2}}$ or $6x^{-\frac{1}{2}}$. A few attempted to integrate both the top and bottom of the fraction. Of those who had rewritten the term correctly as $\frac{3}{2}x^{-\frac{1}{2}}$ some made mistakes when simplifying the coefficient of the integrated term. $\frac{3}{4}x^{\frac{1}{2}}$ was seen several times. Sometimes the correct unsimplified expression was seen first but several candidates just wrote down their answer without showing their workings. Quite a few omitted + c following 3 correct terms and lost the final A1. Some candidates still lack confidence with notation such as an integral sign or dx appearing on the final line which resulted in the final mark being lost.

Question 2

This question proved to be a successful question for many candidates with many being able to score most of the marks.

In part (a) the most common error here was to omit $\mathrm{f}(-3) = 0$ in their response losing the A mark. A minority of candidates failed to use the Factor Theorem required and proceeded to do algebraic long division which did not score any marks. A number of candidates used incorrect language such as stating that (x+3) was a root of f(x).

In part (b) the vast majority scored full marks here using division very successfully. If candidates had done algebraic division in part (a), then as long as they used this result in part (b) then they were able to score still for this earlier work.

In part (c), the majority of candidates understood the idea of using the discriminant to prove the quadratic part had no solutions. Most were able to correctly evaluate the discriminant correctly although some achieved a value of -41 instead. With many responses, they often lacked a convincing conclusion clearly stating that as the quadratic had no solutions then $\mathrm{f}(x) = 0$ has only one solution. Many just stated that the quadratic had no real roots or just showed the discriminant was negative and so only one root. Some incorrectly stated (x+3) as the real root. A few candidates chose to use the quadratic formula and show two imaginary roots and one real root. These candidates were often successful, but some just embedded the values into the quadratic formula and stated "math error" for example which was not sufficient explanation.

Part (d) was poorly answered if it was attempted at all. The most common wrong answers seen were 8, 5, -2 and 400 whilst the correct answer was rarely seen showing poor understanding of the question.

Question 3

Many candidates tackled this question well, scoring full marks. Only a few made either no attempt or scored 0 for their efforts. The use of diagrams was widespread and seemed to aid those candidates in parts (a) and (c) to clarify their work.

In part (a), errors were either adding the given vectors, subtracting the incorrect way round, or arithmetic errors involving negative numbers. Many candidates chose to use $-\overrightarrow{PQ} + \overrightarrow{PR}$ rather than $\overrightarrow{PR} - \overrightarrow{PQ}$ and seemed to have more success with the **j** component.

In part (b), the concept and calculation of the magnitude of a vector was clearly understood by the vast majority and this was evaluated with very few errors seen; the A mark was usually only being lost by candidates with a component error in (a). A minority of candidates attempted to construct a scale drawing: most of these were unsuccessful at providing sufficient evidence to score the method mark.

Part (c) did provide problems for a number of candidates, although a pleasing number provided full solutions which were often concise. Some continued down the line of attempting to calculate magnitudes using the answer to (b) and magnitudes of the given vectors, whilst others failed to find the appropriate proportion of $\overrightarrow{QR}$ (usually using $\frac{2}{3}$ or $\frac{1}{3}$). The other main error seen was candidates failing to take proper account of the direction of $\overrightarrow{RS}$. Others just found the appropriate proportion of $\overrightarrow{QR}$ but did not provide a full method and scored no marks as a result.

Question 4

Many candidates did not attempt part (a)(i) or tackled it poorly. However, the majority of these candidates were still able to go on and score some marks in part (a)(ii) and part (b) and this resulted in a significant proportion of candidates achieving all 3 of the final marks.

In (a)(i), the correct statement of the cosine rule usually produced a full solution, even though several responses clearly showed amendments to once flawed working to be able to reach the given equation. Here, some candidates attempted to fudge their working to correct their work but were unsuccessful in correcting each line fully. The common errors seen were the failure to change signs when removing brackets after a minus sign and candidates multiplying the entire RHS of the equation by $\frac{1}{2}$ when applying $\cos 60$ rather than just the $-2x(x-7)$. The absence of $"=0"$ was rare but still occurred.

In (a)(ii), the $x=-\frac{16}{17}$ was not always rejected, although almost all of these candidates used $x=3$ in part (b) and were able to gain credit. Very few candidates used both values in part (b).

Errors in part (b) were few and far between. The main problems that occurred included incorrect manipulation of the sine rule (usually scoring M1A0) and the use of the incorrect sides in the sine rule (scoring M0A0). There were some very long-winded routes seen, with the area formula attempted twice and the cosine rule used, both with limited success.

Question 5

Generally, candidates found this question accessible with many scoring consistently throughout.

In part (a), most candidates were able to make progress often correctly establishing the values of *p* and *q* following a valid method. A significant proportion of candidates, who correctly calculated the values of both *p* and *q*, failed to write down “a complete equation for the model” in the required form, and a small minority candidates failed to evaluate *p* and *q* to four decimal places. The need to carefully read the question’s requirements should be emphasised to candidates and whilst in a number of questions we will allow anything which rounds to that level of accuracy, the modelling questions in particular can sometimes require a specific level of rounding to score full marks.

In part (b), generally candidates understood that the demand of the question was to interpret the values of *p* and *q* in context although some answers such as “it is the gradient of the line” were seen.

Most candidates were able to interpret the model well enough to understand that the value of *p* was the initial mass in kg of the algae in the pond. Those that failed to score this mark usually referred to the “amount” of algae rather than the mass of algae.

Candidates needed to understand that the constant *q* was the rate at which the mass of algae increased each week. It was a common misconception that the *q* was the amount the mass of algae increases by each week. Incomplete explanations without reference to the time frame were also common for example, “the constant *q* is the rate at which the algae increases.”

In part (c), candidates who had a correct equation were generally able to complete the substitution successfully. Some candidates gained full marks after having incorrectly answered part (a), by using the equation linking $\log_{10} A$ and t given in the question. As it was a modelling question, units were required to score this mark; most candidates used the correct units. This part of the question was also well attempted by many candidates. Those who found difficulties often tried to use $t = 8$ which was information given for use in part i.

In part (d), there were two limitations of the model: the first being the fact that it predicted unlimited growth and the second being that it predicted that the rate of growth remained constant. Most candidates successfully identified one of these limitations and were able to give a sufficient reason to explain in context why this was unrealistic. Common explanations included a change in conditions – sunlight/temperature changes, algae dying or being removed, and the pond eventually being fully covered and the algae running out of resources to consume, leading to a slowing of the growth rate.

Question 6

The binomial question was fairly typical in its structure, so most candidates were able to make a lot of progress in part (a), but part (b) proved to be much more challenging.

Part (a) was general answered well, with almost all candidates scoring at least the first 2 marks. Of those who did not score all of the marks, the most common mistake was ignoring the negative sign in the bracket. Candidate dealt well with the coefficient of *x*, remembering in most cases to apply the power to it.

Part (b) on the other hand was misunderstood by many candidates. Several simply stated the coefficient of the x^2 term in their expansion, or attempted to multiply the bracket by their coefficient of x^2, leading to variations of $\frac{\left(504x^2 - 504x^3\right)}{x}$. A significant minority understood what was being asked of them, but incorrectly wrote $\frac{1}{2x}$ as $2x^{-1}$ instead of $\frac{1}{2}x^{-1}$.

Question 7

Generally, candidates scored well in the first two parts of this question, by factorising the cubic expression and drawing a graph. The final part, however, where the candidates were required to find a range, was very poorly answered, with few gaining any marks and very few reaching the correct final answer.

In part (a) almost all candidates successfully identified the factor of *x* and were able to take this factor out of the expression correctly. Many candidates were confused by the negative x^3 term and it was common to see sign errors in their final answer $x(x+3)(x-3)$ was a common incorrect answer, possibly made after using the equation solver on the calculator to find the roots 3 and -3. Time permitting, candidates should be reminded to check that their factorisation is correct by expanding the result.

Part (b) proved to be accessible to most candidates and there were many fully correct responses seen. Candidates who had made a sign error in part (a), were often able to recover and went on to draw a completely correct graph. Axes were labelled with a scale in almost all diagrams. However, a minority of candidates dropped one mark by sketching the graph of a positive cubic (with the correct roots), whilst a few candidates did not have their negative cubic curve going through the required roots.

Part (c) proved to be very challenging. Candidates were unable to identify the need to differentiate with many of them treating the equation as if it were quadratic and attempting to find the discriminant. Candidates who recognised the need to differentiate generally went on to find the *x* coordinates successfully, however, it was common for these candidates to write an inequality in terms of *x* rather than moving forward to find the associated *y* coordinates. It appears many candidates are not truly confident in the specific meaning of the terms "domain" and "range".

Of the relatively few candidates who did correctly calculate the *y* coordinate of the turning points, some still lost the final mark by failing to use correct set notation. A few responses were seen where decimal approximations to $\pm 6\sqrt{3}$ had clearly been obtained from calculator technology alone and these gained no credit.

Question 8

This question was reasonably well attempted. Logs continue to be an area of challenge for many candidates but despite this, a significant proportion were able to earn a good number of marks here.

In part (a), many candidates were able to earn the mark for recognising that it was necessary to set $t = 0$ and correctly obtained $k = 0.8$. The most common error here occurred when candidates assumed, in error, that $e^0 = 0$ and so obtained $k = 2.2$

In part (b), the majority of candidates were able to recognise that they needed to set their equation for *P* equal to 1. Those who had achieved $k = 0.8$ in (a) usually made good progress and scored full marks in this part. Those candidates who obtained $k = 2.2$ were able to make a first step in solving the equation. They were, however, limited in their progress as the equation was ultimately unsolvable, but many attempted to persevere through taking logs of a negative value which was not creditworthy. Some candidates misunderstood the context here and thought that they needed $P = 1.2$, perhaps misreading the question which asked for a drop to an air pressure of 1 kg/cm^3 rather than a drop in air pressure of 1 kg/cm^3. Nonetheless these candidates were usually able to make good progress as the resulting equation was solvable in this case and some good log work was seen. There were a small proportion of candidates who were clearly less secure in their log work however and some attempted to take logs of each term separately before rearranging or neglected to divide by 1.4 before taking logs. A small number of candidates attempted to use $\log_{10}$ rather than natural logs. Almost all candidates realised they need to show all stages of their working and it was rare to see answers appear from nowhere due to overreliance on a calculator.

Part (c) of this question was a good differentiator and was a challenge to many candidates. For a significant proportion of candidates, "rate" did not signal the need for rate of change and hence differentiation. It was common to see candidates simply substituting in $t = 2$ into their equation for P to obtain $P = 1.32$. Of those candidates who did attempt to find $\frac{\mathrm{d}P}{\mathrm{d}t}$ many seemed to struggle with the chain rule. Some candidates obtained results of the form $Ate^{-0.5t}$, whilst others retained the constant term 0.8 when differentiating. Others began by substituting in $t = 2$ and then proceeded from e^{-2} to e^{-1} or ‘differentiated’ e^{-1} to get e^{-2}. It was common for candidates who were able to progress to a correct value to give the final answer of −0.258 rather than 0.258 but this was condoned.

Question 9

Candidates still find working with logs a challenge and this type of question requires a careful approach to applying the laws of logarithms and making use of the “hence” which linked the two parts together.

Many candidates found part (a) difficult and hence this impacted on the overall scores. It required the understanding and use of logarithm laws. A majority were unable to write part (i) in terms of p often because they could not simplify $\log_3 9$. Part (ii) was more successful.

In part (b), a pleasing number of the candidates received full marks with the majority not connecting part (a) to part (b), often starting again from the original equation and using laws of logarithms. Those candidates that did see the link often went on to find $p = -2$ and thus $x = \frac{1}{3}$. However, a significant number stopped after finding the value of p rather than x. Those that had the linear terms correct in part (a) found this part easy and many proceeded to gain full marks.

Overall, there were far too many candidates unable to make any progress with this question on logs and many indicated a lack of understanding of the relationship $p = \log_3 x \Leftrightarrow x = 3^p$

Question 10

This question was, on the whole, well-attempted and provided some differentiation between candidates.

In part (a), the majority of candidates were able to correctly work through the steps required to derive the equation of the tangent to curve C. The vast majority were able to successfully and accurately differentiate the equation of the curve and to evaluate it at $x = 4$ to find the gradient. Most were then able to determine the y coordinate of P (although some candidates appeared to use the equation of the tangent to find this value rather than the equation of the curve). Most were confident and well prepared to correctly find the equation of the tangent, commonly using $y - y_1 = m(x - x_1)$ but also often $y = mx + c$ equally successfully. A small number of candidates incorrectly worked with the gradient of the normal rather than the gradient of the tangent and there was sometimes confusion between the value of the gradient and the value of the y coordinate at P: $\frac{13}{6}$ and $\frac{13}{3}$ respectively. There were a small number of candidates who worked from the equation of the tangent and who appeared to be attempting to verify this equation rather than deriving it.

Most candidates made an attempt at part (b), and many were able to undertake some integration correctly. There were sometimes slips on the fractional powers and the coefficients. This question was effective at differentiating between those candidates who were able to clearly identify a strategy to determine the required area and many were successful in doing so. Most who were successful, employed the main mark scheme approach of determining the area under the curve between $x = 0$ and $x = 4$ followed by subtracting the area of the triangle however there were a number of different approaches seen, including finding the area under the curve from $x = 0$ to $x = 2$ together with the area between the curve and line between $x = 2$ and $x = 4$. Errors were perhaps a little more common in the second of these two approaches perhaps due sign errors when subtracting the two equations. Unfortunately, though, a number of candidates were not clear on the strategy required and so it was not uncommon to see attempts which stopped after calculating the area under the curve between $x = 0$ and $x = 4$ and thus a value of $\frac{76}{9}$ was a fairly common incorrect final answer. Others using one of the alternative approaches simply found the integral of the difference between the two equations between $x = 0$ and $x = 4$ or between $x = 0$ and $x = 2$ and failed to go on the find the area under the curve separately. Most candidates had few issues identifying the intercept of the tangent with the x-axis but there was sometimes confusion in identifying the base and/or the height of the triangle when this was required to find the area. Some candidates lost the final A mark in this question by not giving the exact answer, giving it as a rounded decimal instead.

Question 11

This question often enabled candidates to score marks in the first part, however, part (b) proved to be very good at discriminating between the most able candidates.

In part (a), there were very few non attempts. Unfortunately, some did not know how to complete the square correctly and used 10 and 8, thus losing the marks. The majority of candidates achieved full marks, however or two marks because of a slip, usually in finding the radius.

Part (b) was challenging for many; non attempts or attempts which achieved no marks were common. Quite a few candidates scored the B mark for the gradient of the perpendicular and some went on to find the equation of the normal, but they did not find the point of intersection of the straight lines and so could not progress to the remaining marks. It was common to see one of the straight-line equations substituted into the equation of the circle. Those who substituted the normal equation and had also found the point of intersection of the straight lines, often correctly found the distance between the points correctly and gained full marks. Those who found the distance between the centre and the point of intersection of the straight lines, often forgot to subtract 3 for the radius, thus losing the last two marks. A large number of candidates found the y intercept of the line l, and then the distance between (0,3) and the centre. A very small number of candidates used a vector method.

Question 12

This was one of the most challenging questions on the paper for candidates, although it was a familiar structure to this type of problem and there was access to later parts as part (a) was a "show" question.

Many candidates struggled with part (a). A few were able to gain the first B mark or make an attempt to sum the areas of the component parts, but many were unsure what to do with the 0.04 and 0.09. A significant number equated these to the expressions for area. Better candidates were able to clearly identify the two circular ends and the curved surface, attaching the correct costing to each and eliminating the *h*. The small minority of candidates then scored 3/4 as they omitted to use C = or Cost = .

Although the answer was given for part (a) numerous candidates made no attempts in the later parts or failed to differentiate part (b) and so made no progress with part (c) or part (d).

Most candidates achieved at least a method mark in (b) for attempting to differentiate. A significant number of candidates set the second derivative equal to 0 and solved, instead of the first derivative.

In part (c), it was common for many of those who had understood the demands in part (b), to progress and find the second derivative. A lot were unsure what to do with it at this point, however, with a significant number equating it to zero and solving (sometimes when they had already solved correctly for 3.26 in (b)). Of those who achieved a positive answer in (b), most were able to substitute into the model for M1 here.

It is clear that many candidates had not read the question carefully or checked their answer, as a lot of candidates gave the answer £13 instead of 13p in part (d), which fortunately for them was condoned on this occasion. Candidates could be encouraged to sense check their modelling questions more as there were a variety of clear unfeasible answers here, including negative answers, and many hundreds of pounds. Many also did not read that their answer should be rounded to the nearest integer, and lost marks unnecessarily.

Question 13

There were a number of completely blank responses to both parts of this question. This was either due to timing on the paper or possibly due to this topic not having been covered in sufficient depth due to disruption to learning.

In part (a), most of the attempts started with the LHS. Many scored no marks at all but quite a few combined terms with a common denominator to achieve the first mark, usually $\frac{1+\sin\theta}{\cos\theta}$.
However, very few progressed from this with many using "identities" such as $1+\sin\theta \equiv \cos\theta$ and $\cos\theta \equiv 1-\sin\theta$ to get to the RHS. Candidates should avoid approaches to this type of problem involving an identity where it is treated as an equation where possible.

In part (b) it was pleasing to see candidates making an attempt although there were quite a few with nothing at all correct. These often had incorrect or irrelevant identities, resulting in equations which could not be solved for sin 2*x*, meaning that they could not access the last method mark. Those who did achieve $\sin 2x = \frac{2}{3}$ (or −1) usually solved correctly to get, at least, one value of *x*, usually *x* = 20.9 and very often the second value too. Most who got to this stage usually rejected any other values and scored full marks. Often, they had cancelled the cos $2x$ earlier in their working, so they did not have to reject the extra values at the end. Usually this should be avoided, although on this occasion the domain meant that this did not affect their final answer. It was pleasing to see that candidates had not tried to answer the question entirely by calculator by just stating the angles and the use of radians rather than degrees was not typically seen. Many did not recognise the relevance of part (a) and began this part from scratch, often successfully, even though they had not shown any relevant working for part (a).

Question 14

This question was poorly answered by the vast majority of candidates, although its position on the paper reflected that this topic is still a challenge to many.

In part (a), many candidates focussed inappropriately on $x=9$ and $x=\pm 3$, taking no account of the > signs in the question. For those choosing to correctly look for counter examples, a lack of brackets (e.g. -4^2) meant their work was inaccurate and they did not score the mark, or they did not give an acceptable conclusion. Several candidates only considered $x>3$ and it was surprising how many candidates concluded the statement was true as a result. Finally, some candidates misinterpreted the syntax of the question, resulting in answers like "sometimes true", which gained no credit, even though they had recognised the values required to find a counter example.

In part (b), the few candidates gaining any credit managed to factorise and then occasionally state that these were consecutive values, thus gaining 1 or occasionally 2 marks. A rare candidate went on to achieve the final accuracy mark using this approach with correct reasoning.
The most common attempts generally included consideration of n being even and then n being odd with appropriate substitutions into the factorised expression and then an algebraic attempt which could not make any progress. Less common was an attempt to write n as the variations of $6k$, $6k+1$ etc. and complete similar algebraic work. This produced multiples of 6 but almost all candidates failed to progress to show the result holds for all 6 cases.

A few attempts at induction were seen. These normally started with a factorisation, the use of $n=1$ and attempts at algebraic manipulation to the stage showing $\mathrm{f}(k+1)=\mathrm{f}(k)+\mathrm{g}(k)$. Here, candidates generally made errors in the getting the coefficients of $\mathrm{g}(k)$ or failed to factorise to the point at which they could reasonably conclude that $\mathrm{g}(k)$ was a multiple of 6, instead often incorrectly changing their expression so that a factor of 6 then appeared.